4.0 Past Environmental Management Practices

ORGDP operations have resulted in the release of a variety of contaminants into the environment through stack and diffuse air emissions; from liquid discharges into ponds, ditches, and rivers; through accidental releases; and from past waste disposal practices, such as the burial of low-level and hazardous waste. Requirements governing the release of chemicals and radionuclides into the environment were limited in the early years of ORGDP operations. The AEC established allowable limits for the release of radionuclides into the environment, but Federal and state agencies had few restrictions governing discharges and disposal activities until the late 1960s.

Releases from U.S. industrial operations during the 1940s, 1950s, and 1960s, including those at ORGDP, were significant. Past ORGDP operations and spills resulted in the release of radionuclides and chemicals in the vicinity of the Plant and the transport of these contaminants to local streams and groundwater. These practices resulted in significant degradation of the environment in the vicinity of the Plant. While consistent with much of industry and other DOE sites, these practices resulted in ORGDP being listed, as part of the Oak Ridge Reservation, on the EPA's National Priority List as a Superfund site. In November 1991, DOE entered into a legally binding agreement with EPA to remediate the site. As described in Volume 2 of this report, significant activities are ongoing at the Plant to complete the actions governed by this agreement.

ENVIRONMENTAL MANAGEMENT PRACTICES

- *Sanitary, Hazardous, and Radioactive Waste*
- *Management and Disposal of Scrap and Surplus Materials*
- *Liquid Effluents*
- *Atmospheric Releases of Radioactivity and Fluorine/Fluorides*
- *Sanitary Water System*

The presentation of historic environmental management practices is structured in large measure on the nature and scope of regulations that govern treatment and disposal of waste materials, management of materials with potential economic benefit, and protection of water quality and air quality. Accordingly, this section describes historic practices associated with management of sanitary, hazardous, and radioactive waste; management of scrap and surplus materials; management of liquid effluents; management of atmospheric releases of radioactivity and fluorine; and management of the sanitary waste system.

4.1 Sanitary, Hazardous, and Radioactive Waste

- *Sanitary Waste Management*
- *Hazardous Waste Management*
- *Radioactive Waste Management*

Large quantities of solid waste (trash), hazardous waste, and radioactive wastes were generated through the construction, operation, and decontamination activities at ORGDP. AEC expectations, regulatory requirements, and operating company programs to manage these waste materials significantly evolved during the life of the Plant. Specifically, in 1965 the Solid Waste Disposal Act (SWDA) was enacted to address municipal solid waste, principally non-hazardous wastes. In 1976, Congress passed RCRA to emphasize the treatment and disposal of hazardous waste. In 1984, RCRA was amended through passage of the Hazardous and Solid Waste Amendments (HSWA). Subpart C of HSWA governs management of hazardous wastes. In these regulations, the concept of solid waste is one of the more complicated notions in RCRA. RCRA defines solid waste as "Any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities."

Beginning in 1943, waste generated from construction activities and worker housing camps was disposed of in convenient areas of the site with few controls. As Plant operations began to generate waste, treatment pits and ponds and additional disposal sites were developed, including sanitary landfills, burn pads, incinerators, classified burial sites, and oil biodegradation plots. Appendix C shows the locations of major treatment and disposal facilities used at ORGDP over its history. To the extent available, the appendix provides the operating period, the material/ waste disposed of, and current status. All facilities listed in Appendix C are either closed or are awaiting remediation under CERCLA. After ORGDP ceased operations, a number of treatment facilities continued to operate, including the Central Neutralization Facility and the TSCA incinerator.

Prior to the establishment of a separate environmental organization in 1971 to manage site waste storage and disposal operations, waste management functions were performed by a variety of Union Carbide Corporation organizations. For example, in 1947 actions to address radioactive waste involved the cascade services, design and development department, and uranium control and inspections organizations. By 1957, the safety, fire, and radiation control department had responsibility for recommending acceptable limits for disposal of radioactive waste. Beginning in the 1980s, the operating contractor's health safety and environmental affairs (HS&EA) organization provided environmental support to operating and maintenance groups. In 1991, the waste management function in HS&EA became a separate division that included technical and management functions as well as operations.

Over time, environmental support functions also developed within DOE. The OR safety division performed health and safety appraisals of operations at ORGDP. Beginning in 1966, these appraisals addressed environmental considerations. In the early 1970s, this division became the safety and environmental control division, and in the 1980s, a separate environmental protection division was formed. In 1989, the waste management function, which had expanded within the environmental protection division, was established as a separate division to provide technical and management support to line organizations.

4.1.1 Sanitary Waste Management

Sanitary wastes generated by Plant construction and operations include both construction debris and general refuse from manufacturing and support processes. Numerous locations around the Plant (see Appendix C) and across the Oak Ridge Reservation were used for disposal of these materials, many of which require additional remedial actions under current environmental regulations.

One of the first major disposal sites was created during removal of the initial construction facilities. This site, known as the JA Jones disposal area (located along Contractor Road and north of the K-1007/P1 pond), also received common trash and operated during the mid-1940s. Another area used for waste disposal during this period was the north trash slope (north of the K-25 building), which operated until the early 1950s. In addition to sanitary wastes, some hazardous wastes, such as instruments containing mercury, oils, paints, and solvents, were reportedly dumped onto the slope. In the 1950s, surface trash in this area was cleaned and the remainder buried as part of the construction of the K-1066K cylinder yard. The K-901A north waste disposal area was used from the late 1940s until the mid-1970s for disposing of paint, lumber, roofing material, and construction debris.

A pit (located one-quarter mile north of ORGDP) used in 1974 by Tennessee Valley Authority (TVA) also became a spoils disposal area used by contractors. This site, also known as the contractor's burial ground, routinely was used to bury scrap lumber, concrete, soils, and non-contaminated roofing material from ORGDP. In addition, the burial ground received empty aerosol cans, fly ash, waste oil, lime sludge, and process cooling water from the centrifuge program. Administrative controls were subsequently established to prevent the introduction of hazardous materials, but records indicate that 24 loads of hazardous material and one load marked radioactive waste were buried at this site.

The K-701 powerhouse produced another significant source of solid waste from early ORGDP operations—fly ash—which was sent to the K-720 fly ash pile from 1944 until 1950, when the Plant converted to natural gas. During this period, nearly six million tons of coal was combusted in the powerhouse, creating large quantities of ash, slag, and coal fines. To control the acidity of runoff from the slag pile, sewage sludge was sprayed on the pile. Since controls were limited on discharges to the sanitary sewer, radioactively contaminated material was fed into the sewage treatment plant, and a portion of this material settled out with the sewage sludge.

The use of open burning as a disposal method began in 1945 at the K-1099 Blair Road quarry. This quarry received combustible waste, cafeteria waste, lumber, construction waste, electrical equipment, asbestos, oil, and chemicals to be burned or buried. PCB-contaminated waste oils were also likely burned at this site. Additionally, both burial and open burning occurred at the Poplar Creek disposal area (located northeast of the K-1064 peninsula

K-1099 Blair Road Quarry Used for Open Burning of Plant Waste

and north of Poplar Creek Road), which operated from the 1940s until the TVA Roane Substation was built on the site in 1975. This site was used for disposal of construction debris; no hazardous or radiologically contaminated waste was documented as having been shipped to this site.

Management controls were not always comprehensive or effective in separating general trash from chemical and radioactively contaminated wastes destined for land disposal. For example, although Plant policy was specific about not using the K-1099 Blair Road quarry for disposal of contaminated materials, radiological contamination was discovered in 1991 in the quarry. Improper segregation of wastes at points of collection contributed to improper disposal. When early disposal sites were closed, dumpsters were placed around the Plant to collect sanitary waste for transport to and disposal at Y-12. In 1968, a concrete pad and ramp were constructed in the K-1064 area and, in conjunction with a new compaction-trailer, used to receive the contents of the sanitary waste dumpsters. Other than color coding dumpsters to identify their intended use, there were few physical or administrative controls to prevent inappropriate materials from being placed in the dumpsters. Interviews with former employees revealed that paint cans, oils, oily rags, solvent cans, paper, asbestos, wood, and metals from many facilities, including process buildings, were inappropriately deposited in the sanitary waste dumpsters. Subsequent investigations have determined that the compactor ramp and building were radiologically contaminated, indicating a failure to control the introduction of radioactive wastes.

4.1.2 Hazardous Waste Management

During Plant construction and the early days of operation, waste was not characterized to identify many chemicals and other hazardous materials that later regulations would classify as hazardous waste. These hazardous materials were either disposed of as solid waste (trash) or transferred to one of several liquid treatment systems as shown in Appendix C. However, a few toxic and poisonous chemicals did receive special handling and disposal. A 1950s-era logbook on the handling of non-radioactive poisonous and toxic waste materials indicates that some hazardous materials were disposed of off the Plant grounds. For example, compressed gas cylinders of hazardous materials were vented and bottles of cadmium chloride were broken at locations away from the main Plant site. Documents indicate that ferric nitrate and hydrogen peroxide were dumped from the White Wing Bridge over the Clinch River, several miles from ORGDP.

Treatment Actions and PCB Management

Beginning around 1946, a deep pit was used to burn contaminated oils, solvents, carbon tetrachloride, and PCB-contaminated paints. This pit was located near an old farmhouse that had been converted into a firehouse and was aptly named the K-1085 firehouse burn area. This pit was used until about 1951, at which time the pit was filled with dirt. After closure of the pit, sheet metal pans on concrete pads were used to burn off the flammable liquids (outside the ORGDP perimeter fence and bounded by State Road 58, East Gallagher Road, and Powerhouse Road). Over its operating life, an estimated 100,000 gallons of flammable liquids were burned in this pit.

During production, large ventilation ducts were used in the process buildings. Gaskets used in these ventilation ducts were treated with PCBs. Over time, these gaskets became saturated with lubricating oils that dripped out of the gaskets. This oil was radioactive, was contaminated with PCBs, and had to be collected using a trough system. In 1974, actions were being taken to identify PCB equipment and to label transformers. A PCB storage area was established in K-25. In 1977, a PCB program was implemented, followed in 1978 by a formalized waste disposal program. As a result of these efforts, hazardous waste that had been disposed of by discharge into liquid treatment systems, burial, or burning began to be containerized for disposal.

By the end of the site production mission in 1985, regulations established pursuant to TSCA required PCB inventories to be maintained and to limit the allowable storage time of PCB wastes to one year. As a result, PCBs that were not radioactively contaminated were shipped by rail to a commercial disposal operation for incineration. However, most PCBs at ORGDP were

Replacement of PCB Treated Gasket in Process Building

radioactively contaminated and required long-term storage pending development of approved treatment systems. In 1986, the PCB waste in storage at ORGDP totaled 325,000 pounds. In addition, 129 PCB transformers and 9,656 capacitors were in use or in standby in the event that the Plant was restarted.

The need to treat this large volume of radioactively contaminated PCBs resulted in a decision to construct an incinerator at ORGDP. However, until this incinerator was approved, permitted, and constructed, PCB wastes were stored in the K-711, K-726, and K-306-1 facilities. In 1988, over 7.5 million pounds of PCB and radioactive wastes were received from Portsmouth Gaseous Diffusion Plant for storage pending treatment. As a result of these waste streams at OR sites and other DOE sites, DOE and the EPA signed an agreement to allow storage beyond one year. The construction, permitting, and eventual operation in 1991 of the K-1435 TSCA incinerator provided a way to manage these contaminated PCB wastes.

Storage and Disposal

During 1969, a Hazardous Waste Committee was formed to aid personnel in the proper disposal of hazardous materials. In anticipation of proposed regulations on hazardous waste management, site personnel developed procedures governing the disposal of hazardous materials. In 1980, DOE determined that RCRA requirements did not apply to Atomic Energy Act (AEA) authorized activities. As a result, the regulatory incentive to achieve compliance with external requirements was eliminated. However, a legal decision on April 13, 1984, determined that the application of RCRA to DOE activities was not inconsistent with the AEA. Beginning in 1986, the Tennessee Department of Health and Environment (TDHE) routinely conducted hazardous waste inspections at the Plant. These inspections identified a number of concerns, and as a result, the Plant periodically received notices of deficiencies and notices of violations.

By June 1987, DOE and EPA had reached an agreement and permits were filed for facilities being used to store regulated hazardous waste. In 1989, TDHE issued a permit for ORGDP, specifying the requirements for hazardous waste operations. Since many of the ORGDP facilities being used to store hazardous waste did not meet regulatory requirements, a project was begun in 1992 to convert the K-25 building vaults into compliant storage by incorporating dikes and sealed floors. This project was necessitated by a DOE decision that restricted the disposal of radioactive and mixed waste via offsite vendors. As a result, very large amounts of mixed waste were stored in the K-25 building vaults. In addition, since the site did not know which offsite vendors would be utilized in the future, waste was characterized only for purposes of storage. As discussed in Volume 2 of this report, the effects of this incomplete characterization continue to impact waste management activities today.

Used oils were routinely released to the environment. From 1982 to 1984, a total of 53,200 gallons of oil were land-farmed or used on roads for dust control, including roads at K-1070C/D, the contractor burial ground, Flannigans Loop roads, Duct Island roads, and the K-1414 cylinder yard. Land-farming was a practice that applied oils to facilitate biological degradation of organic materials. This oil was reportedly tested and rejected if it either was contaminated with uranium or contained over 1 percent chlorinated hydrocarbons or PCBs in levels exceeding 5 ppm. Not all waste oils were appropriately screened prior to spreading. In 1983, about 2,000 gallons of oil with relatively high levels of uranium were land-farmed along the C-trench (located at K-1070C/D). After this oil was biologically degraded, the oil-treated soil was scraped off and buried in the C-trench. In addition to these 53,200 gallons of oil, 5,000 cubic feet of fuller's earth was applied to the surface of what is referred to

Mixed Waste Drums Being Moved to Permitted Storage

as the K-1070A land farm. This area was south of the K-1070A landfill; the fuller's earth was used as a filtration medium to remove acids, sludges, and degradation products from cascade lubricating oil. Before application, the spent fuller's earth was tested for PCBs and found to be within specifications for land farming.

4.1.3 Radioactive Waste Management

Radioactive wastes were routinely generated by ORGDP operational and maintenance activities and required establishment of treatment and disposal practices. Consistent with the standards of the time, many of these facilities did not contain engineering controls to limit release of contaminants to the environment.

Treatment Practices

Incineration of radioactive waste materials was a longstanding waste treatment practice at ORGDP, beginning soon after initial operations. Incineration was primarily used as a first step in the recovery of uranium from contaminated combustible materials. Uranium-contaminated materials that were commonly incinerated included paper, gloves, shoes, spent carbon adsorption media, rags, oils, plastics, and oil sludge. Oils were routinely burned, and some may have been contaminated with PCBs. Through burning, the uranium was concentrated in the residual ash; this was subsequently recovered as uranium oxide through chemical leaching in onsite recovery facilities or sent off site.

The use of incinerators at ORGDP facilitated the recovery of valuable uranium that otherwise would have been discarded into the environment. However, this technology also created a number of hazards to workers and the surrounding environment. Incinerators concentrate non-combustible contaminants, such as radionuclides, in resulting ash. Ash is composed of dry and highly mobile powder, presenting inhalation hazards to workers at or near these facilities. While little information is available on early incinerators used at the site, they lacked modern pollution control equipment such as scrubbers and relied on workers to manually control operations. As a result, some particulates that were entrained in combustion gases were released through incinerator stacks.

The first documented incinerator was constructed in 1947 in a temporary building known as T-8 (later renamed K-1045). The incinerator operated until at least 1951. Beginning around 1949, a furnace was installed in K-1031 to burn combustible contaminated wastes. The K-1031 incinerator was likely a source of significant radioactive contamination within the facility and in the area surrounding the building. This furnace processed uranium and transuranic contaminated wastes from both cascade operations, K-1131 feed production operations, and decontamination facilities. This unit operated well into the period that the feed plant was processing Hanford Site and Savannah River Site reactor returns. The duration of this incinerator's operation is not known, but it is not believed to have operated much past the 1955 startup of a more modern incineration facility at K-1420. Some references to other incinerators in K-1410 and K-1203 were found, but no detailed information could be located.

Three generations of incinerators were installed in a building near K-1420. The initial K-1420 incinerator facility (later renamed K-1421) was put into operation in 1955 and consisted of two gas-fired incinerators in a building adjacent to the main K-1420 building. An exhaust dust collection system was installed to reduce the release of particulates to the environment. This facility burned both contaminated solids and waste oils collected throughout the Plant, including items contaminated with enriched uranium from the cascades, and items from the K-1420 decontamination processes containing both uranium and transuranics. This facility was replaced around 1972 with a new unit, at the same location, that had three separate furnaces with a common air handler and stack. A gas-fired secondary combustion changer was used to reduce particulate emissions. The facility had few automated controls and relied on operators to follow established operating instructions to ensure optimal burning. Operators stated that they did not have written operating instructions for the incinerator. They also noted that the facility periodically emitted thick, black smoke from the stack, indicating incomplete combustion and leading to the release of particulates into the environment. This unit was shut down due to performance problems in 1982.

An upgrade of the K-1421 incinerator was then placed in service. This facility was automated to reduce reliance on operators and to minimize the possibility of smoke or particulate emissions. In 1985, continuous air monitoring was conducted to determine compliance with State of Tennessee emission standards. Two consecutive tests of the incinerator showed that it failed to meet Tennessee emission limits for particulates. The facility was subsequently permanently shut down. A post-operational assessment showed significant contamination in the environment around the incinerator. Additionally, the interior incinerator components, building roof, and building stack were found to be highly contaminated. The K-1421 incinerator was demolished in the 1990s under the site cleanup program.

After the site uranium enrichment mission effectively ended in 1985, waste incineration became a broader site mission. Efforts began in the mid-1980s to design and construct the K-1435 TSCA incinerator to treat both ORGDP legacy wastes and wastes from other DOE sites. The TSCA incinerator is fully automated and includes a secondary combustion chamber and scrubber to control gaseous and particulate emissions. The facility is permitted by EPA pursuant to TSCA and RCRA regulations. The TSCA incinerator underwent test burns from 1988 through 1990 and began incinerating PCB waste in 1991. Stack emission measurements are reported in the annual environmental reports. An issue relating to the stack monitoring system currently used to evaluate emissions from the TSCA incinerator is included in Volume 2 of this report.

Disposal Practices

Efforts to segregate and dispose of radioactive wastes generated by Plant activities started in the 1940s. The K-1070-A contaminated burial ground, which operated from the late 1940s until March 1976, was used to bury low-level radioactive waste and mixed waste (i.e., mixtures of radioactive and hazardous chemical wastes). The bulk of the material included uranium-contaminated materials, thorium compounds, contaminated UF_6 cylinders, beryllium chips, boron, and contaminated oily rags. Low-level wastes, such as cleaning rags, scrap paper, and trapping media, were also disposed of in the K-1070-A burial ground. These materials were subsequently sent to Y-12 for disposal after March 1976. In 1976, plans were developed, but never implemented, to remove and transfer the remaining waste to Y-12.

Markers Showing Buried Radioactive Waste in K-1070-A

Research activities at ORGDP during 1949 and 1950 used high-level waste from the Hanford Site. Residual materials, including transuranics and fission products, were placed in holes dug in the area of K-1004J. Due to criticality concerns, these holes required proper spacing. Once dug, Monel cylinders about five inches in diameter were placed in the holes, which were then plugged and covered with asphalt or concrete.

In the 1950s, the K-1064 drum and burn area was used for waste operations and disposal. A large metal structure called a teepee was used to incinerate waste materials, including paints, organic wastes, and radiologically contaminated waste oils. After burning was stopped in 1960, the site was used to store drums containing solvents, organics (including PCBs), and


K-1064 Area's Teepee Used to Incinerate Paints and Contaminated Waste Oils

contaminated waste oil. Radioactively contaminated building debris was also disposed of in this area. Site management learned of this waste area when debris and drums were discovered falling into Poplar Creek in the early 1990s. This area also became a long-term outdoor storage location for radiologically contaminated scrap material, resulting in the spread of radiological contamination to the environment.

In the 1950s, Plant wastes were also shipped to the White Wing scrap yard, also known as the "Y" burial ground, located near the junction of Highway 95 and Highway 58 on White Wing Road. The dismantled Fercleve process building, which was part of the S-50 Liquid Thermal Diffusion Plant, was disposed of at this site. One of the S-50 laboratory buildings was reportedly buried in an excavation dug next to the building in a location near the old powerhouse.

ORGDP established a number of landfills to accept classified wastes, including radiologically contaminated materials. Beginning in the 1950s, the Plant used the K-1070-B landfill for this purpose. This burial ground, which had begun along an existing hill along Mitchell Branch Stream, was extended over the former K-1218 Coded Chemical Storage Facility. This 3.7 acre site, now called the old classified burial ground, received compressors and coolant equipment, including radiologically contaminated items from the S-50 facility that had previously been stored at the "Y" burial ground. Some of the ash produced from operation of the fluorine tower reactors from 1953 until 1962 is also believed to have been buried in K-1070-B. Additionally, lead, uranium, copper, beryllium, asbestos, and barrier plant equipment were also buried at the site. After burial ground activities ceased in 1976, the site became the K-1066-B cylinder yard and the K-1045-A fire training facility.

S-50 Building

This old classified burial ground was replaced in 1974 by the K-1070-C/D facility. This new burial ground was located on a hill and extended over 22 acres, 12 of which were used for burial. Several different activities occurred at this site. Disposal trenches were used to dispose of classified material and equipment and packaged asbestos. In 1977, several pits were constructed for disposal of laboratory quantities of corrosives, oxidizers, reducing agents, and containers. Three earthen dike storage areas were constructed in 1979 and used until 1985 for drums of hazardous liquids, including waste oils, solvents, and solvent-contaminated waste oil. These storage areas were addressed in a closure plan approved by the TDHE in 1986.

Two of the most hazardous disposal areas were the K-1407 B and C ponds. These ponds were used to dispose of liquid waste streams that contained uranium compounds, transuranics, and organic and metal hydroxides. Because these ponds received hazardous compounds regulated under RCRA, action was taken in 1988 to remove these ponds from service. This project involved draining the ponds and mixing the remaining pond sludge with cement in steel drums to produce a hardened pondcrete. However, during this project, funding problems and the need to meet regulatory requirements for closure forced the chemical operations department to place untreated raw sludge into drums that were not designed for this type of long-term storage. As a result, while 44,700 drums contained solidified pondcrete, 32,000 additional drums contained raw sludge. The drums of solidified and raw sludge were stored on the K-1417-A and B drum storage yards.

In September 1991, State of Tennessee inspectors discovered that drums were corroding from the effects of weather and trapped or condensed water. The Tennessee Department of Environment and Conservation (TDEC) issued a Commissioner's Order to address this condition. Drums of stabilized sludge were placed in storage at the K-31 and K-33 facilities. The drums of hardened pondcrete were subsequently shipped off site. Chemical Waste Management, Inc., was hired to repackage the drums of raw sludge and place them in newly constructed storage buildings at K-1065. A fatal industrial accident highlighted problems with the safety of this project, resulting in its termination in 1993. Onsite personnel then repackaged the raw sludge in plastic containers designed for long-term storage. At the time of this inspection, the containers of raw sludge were being resealed and shipped to Envirocare in Utah for disposal.

In summary, the generation of many types of sanitary, hazardous, and radioactive waste materials began with Plant construction in the 1940s. Programs and requirements to manage these wastes evolved continuously during the Plant history. Early waste management practices focused on burial and incineration. Waste segregation programs were not fully developed or understood in the years following Plant startup, and it is likely that various sanitary landfills, sewage systems, and other disposal locations received some radioactive and hazardous materials. The evolution of more stringent environmental regulations resulted in diminished or non-existent disposal capacity for many wastes, resulting in increased reliance on waste storage and the development of various treatment technologies at ORGDP, an endeavor that continues to the present day.

4.2 Management and Disposal of Scrap and Surplus Materials

Large volumes of scrap metal and surplus matter were generated during construction, maintenance, repair, and facility upgrade activities at ORGDP. These materials were either managed as waste or stored and managed as commodities for resale. Much of the material was contaminated, and large volumes were disposed of on site. Additionally, large volumes of scrap remain in storage at the site pending future disposal or disposition.

Records indicate that Union Carbide management was aware from as early as the 1940s that contaminated surplus materials could be shipped only to properly licensed and authorized recipients and that radiological monitoring of all potentially contaminated materials being offered for public sale was required. Throughout the Plant's history, the subjects of contamination limits, measurement techniques, and what constituted "de-minimus" quantities of residual radioactive material were debated, and requirements were modified over time. Records indicate that from very early in the process, the AEC intended that very strict controls be placed on any materials with residual contamination that were being considered for release into commercial channels. In 1949, the AEC, in a memorandum to all Union Carbide installations at Oak Ridge, reiterated a 1947 directive stating that "It is essential that action be taken to prevent radioactive contamination from entering commercial channels. You will establish necessary procedures to ensure that it is impossible for materials of this type to lose their identity or to enter commercial channels through sales or transfer of surplus property, salvage and scrap." The memorandum delineated and clarified the contamination limits that applied to the original directive, which had been the subject of debate and uncertainty since its release. The established contamination limits delineated were 500 dpm/100 cm^2 alpha and less than 0.04 mrep/hr beta-gamma (mrep preceded mrad, but the units are similar). These original levels for uranium are even more restrictive than current release standards.

The AEC directives initiated the establishment of corporate procedures governing the handling and disposition of scrap and surplus materials to ensure proper segregation of materials. While contamination limits and material categories changed over the years, scrap material was always required to be segregated by contamination status. The Plant health physics department was responsible for monitoring and tagging scrap materials at the point of generation according to the contamination status. Many workers who were interviewed do not recall being required to segregate scrap material or having it surveyed as suggested by procedure. Scrap materials were taken to designated storage or disposition locations, including clean and contaminated scrap yards at ORGDP. Public property sales were held routinely for disposition of material classified as clean scrap and equipment. Until the 1980s, the health physics department did not typically perform full radiation monitoring of this scrap before sale, although the property sales and stores department performed periodic checks. While it is evident that some material was surveyed, the monitoring was not as comprehensive as defined by previous regulatory directives, and there was evidence that the implementation of contamination limits, defined in disintegrations per minute (dpm), was not well understood. For example, many documents incorrectly refer to these limits as counts per minute (cpm), which, based on instrument efficiency, will always be lower than the actual dpm. For alpha activity, the instruments in use had an approximate correction factor of 3 for conversion of cpm to dpm, and the interpretation of the limit as cpm may have resulted in the inappropriate release of material that exceeded limits. These deficiencies and a number of incident reports suggest that some contaminated materials did in fact enter public and commercial channels through property sales. However, radiation and contamination levels for these materials would probably have been relatively low because highly contaminated materials would have been under tighter control and not put into the scrap for sale program. Surveys, although minimal, would likely have detected contamination levels high enough to present an exposure concern. Exposures to the public for many contaminated materials that were released would have been negligible compared to Plant working conditions because contact with one or a few contaminated items would not be continuous.

The very large quantity of scrap and surplus metal from cascade improvement and barrier production processes presented unique challenges that could not be adequately met via typical scrap disposition and property sale channels. Significant quantities of clean and contaminated nickel, aluminum, iron, and other metals were generated during ORGDP operations, most notably during cascade improvement initiatives in the 1970s, but also earlier. Much of this material was smelted and cast into metal ingots for subsequent rework or reuse for Plant components or for public and commercial sale. The ingots were of continued concern due to the lack of specific requirements governing acceptable levels of volumetric contamination and the difficulty in meeting surface contamination limits. In the 1950s, the AEC was urged to modify the restrictive surface contamination limits originally promulgated. By 1960, new, less-conservative limits were set at 5,000 alpha dpm/100 cm^2 and up to 1 mrad/hr beta-gamma. The laboratory division conducted tests on several batches of nickel ingots, and extrapolations were made using the new limits to correlate surface activity to volumetric uranium concentrations. Data suggested that up to 2,500 ppm uranium might be expected in ingots contaminated at these levels of surface contamination, depending on the assay. Records show that hundreds of thousands of pounds of these ingots were sold or transferred from ORGDP. Regulatory changes in the early 1980s reestablished more conservative surface contamination limits, as well as restrictions on sale of material with volumetric contamination.

In summary, there is sufficient documentation to indicate that ORGDP management understood requirements and tracked regulations concerning disposition of scrap and surplus material and developed programs and procedures to foster compliance. However, given the large amount of scrap and surplus material generated throughout the history of ORGDP, the relatively small number of qualified health physics personnel available to perform radiological surveys, and evidence of inconsistent implementation of required surveys, there is a likelihood that material exceeding appropriate radiological guidelines was periodically released from the site from the 1940s through the 1980s. Such inappropriate releases would not have been expected to create a significant public health concern due to the limited potential for continuous contact and the fact that highly contaminated materials would have been unlikely to have entered scrap channels. However, releases in excess of applicable standards were not in keeping with Department and regulatory radiological policy at the time.

4.3 Liquid Effluents

- *Regulated Outfalls*
- *Routine Historical Discharges*
- *Accidental Releases*

Routine discharges of liquid process effluents and accidental spills of materials containing radionuclides and hazardous chemicals have impacted the environment in the vicinity of ORGDP. Effluents were historically released in a number of ways, including via the sanitary sewage and storm water drainage systems. Effluent material that was not otherwise held up or recovered through wastewater treatment facilities and recovery systems flowed to the various Plant outfalls and storm drains and into Mitchell Branch, Poplar Creek, or the Clinch River. Mitchell Branch received effluent from both uranium recovery and cleaning operations. Formerly named the K-1700 industrial drainage ditch, Mitchell Branch flows into Poplar Creek on the north side of the Plant.

Since 1959, environmental data for ORGDP have been collected and analyzed, and measurements of uranium concentrations in surface streams have been determined. In the early years of operation, samples were collected at six locations: three on Poplar Creek, and three on the Clinch River. However, routine environmental samples were not taken to detect any transuranics and fission products introduced into site process in the 1950s during processing of uranium from reactor returns. Beginning in the mid 1970s, samples for uranium were collected and analyzed monthly, and samples were analyzed quarterly for technetium-99, cesium-137, plutonium-239, and neptunium-237. Similarly, sediments from Poplar Creek and the Clinch River were collected and analyzed systematically from 1976 to 1992 for concentrations of uranium, technetium-99, cesium-137, neptunium-237, and plutonium-239.

4.3.1 Regulated Outfalls

Water quality was enhanced by the promulgation of environmental regulations and the curtailment of Plant operations in the 1970s and 1980s. In the early 1970s, the Clean Water Act (CWA) established the NPDES, which administered effluent limitations and water quality requirements for chemical releases. Surface water discharged into lakes and streams at the Plant is regulated under the NPDES program permitted by the State of Tennessee. Before 1992, the number of ORGDP locations governed by the NPDES permit varied, but has never exceeded more than eight authorized discharge locations; these include Mitchell Branch, the sewage treatment plant, the K-1007-P1 pond, and the K-901A pond. Chemical parameters routinely monitored at the outfalls include total dissolved solids, biochemical oxygen demand, total suspended solids, oil and grease, total residual chloride, trace metals, nitrate, and ammonia.

Since the mid-1970s, all process water discharged from the Plant passed through an NPDES monitoring point. However, many storm drains, some with non-contact cooling water discharges, were not monitored before 1992. Liquid effluent discharge limits for radionuclides were not promulgated by EPA, but were required and published under the AEC and ERDA regulations and later documented in DOE orders as maximum permissible concentrations or radioactive concentration guides in water. Despite the discharge restrictions, enough radionuclides and chemicals have been released by these effluents to create legacy contamination in ponds and creeks. Since ORGDP ceased production, liquid discharges have decreased because of the elimination of blowdown from the recirculating cooling water system and the centrifuge development cooling towers, and because of the decrease in sewage effluent.

In 1986, the CWA, administered by TDEC, required the site to implement a biological monitoring and abatement program (BMAP) for ORGDP. The BMAP was designed to identify substances that accumulate at undesirable levels in biota as a result of site discharges, to determine the significance of those discharges, and to provide a baseline measure of biotic contamination for use in evaluating future mitigation efforts. Elevated concentrations (relative to local reference sites) of mercury and PCBs in biota were found to be associated with the site's NPDES-regulated discharges.

The domestic sewage from ORGDP operations has been handled by the K-1203 sewage system. Interviews with former employees indicated that this contaminated sludge was taken offsite for use as fertilizer in home gardens. This NPDES-regulated outfall was regularly out of compliance in the 1970s and 1980s, primarily for discharging wastewater with elevated chlorine levels. Prior to 1976, wastewater treatment at the site was accomplished in tanks using a settling-type system. After treatment in the tanks, the wastewater was chlorinated and discharged into Poplar Creek. In June 1976, the treatment process was modified by the addition of an aeration or clarifier tank. The design allowed for an average flow of 0.6 million gallons per day (mgd) and a maximum, short-term flow of 1.0 mgd.

In recent years, the sewage treatment facility has been operating at approximately one-third to one-half of its design capacity, with an average flow of 0.2 to 0.32 mgd. The system was subsequently updated to use ultraviolet light disinfection instead of chlorination, a process that virtually eliminated compliance issues. Additionally, the relining project for the sewer collection system, completed in the mid-1990s, reduced the rainwater infiltration into the system. This project reduced the volume of water being treated at the sewage treatment plant, significantly improving facility treatment efficiency.

Surface streams and ponds were used to receive many contaminated process effluents at the site. The Mitchell Branch and K-1407 ponds were the receptors for significant amounts of radioactive discharges, primarily due to the effluents of the K-1420 decontamination facility (see Appendix C). The sewage treatment plant (K-1203) and the K-1407-B and -C ponds also received significant radioactive discharges. The K-1007-P1 and K-901-A ponds received a smaller amount of radioactive effluents.

ORGDP has an extensive storm drainage system containing numerous effluent discharge points, most of which discharge into Poplar Creek. Those that drain the extreme northwestern region of the Plant (i.e., west of the K-33 building) discharge into the K-901-A lagoon and subsequently empty into the Clinch River. While the primary purpose of this system is to control surface water resulting from heavy rains, it was also used to discharge quantities of once-through cooling water from some air-conditioning systems, as well as to transfer small quantities of laboratory wastes to the K-1007-B holding pond.

4.3.2 Routine Historical Discharges

Significant routine historical releases have occurred through the three main holding ponds to Mitchell Branch, Poplar Creek, and the Clinch River. Another significant liquid release pathway was direct discharge to Poplar Creek. Routine discharges of liquid waste have included radionuclides, PCBs, volatile organic compounds (e.g., degreasers), metals, and acids.

Discharges through Holding Ponds

The three holding ponds, K-1407-B, K-1007-B, and K-901-A, were used to neutralize, settle, and dilute chemical wastes. The K-1407-B holding pond, located in the northeastern region of the Plant, was used to settle uranium compounds discharged from K-1420. It also received nitrate, acidic, and caustic wastes from the steam plant water treatment process, neutralized wastes from the K-1401 metals preparation facility, blowdown from the barrier manufacturing facility's recirculating water system, and runoff from the steam plant coal yard. Significant quantities of acidic and caustic wastes were discharged to the pond, causing the pH to fluctuate between approximately 5.5 and 9.0. The K-1407-A pond was subsequently upgraded to allow neutralization of effluents entering the pit to a pH of approximately 7.0. The effluent from the K-1407-B holding pond flowed over a weir into Mitchell Branch, where it mixed with storm drain effluents and subsequently emptied into Poplar Creek about 500 feet downstream of Blair Bridge.

The K-1407-B pond was a receiving body for transuranics at the Plant. The pH conditions in the pond favored chemical precipitation of transuranics; most transuranics settled to the bottom of the pond and were contained in the sludge. When the sludge was removed from the B and C ponds in 1988, it filled approximately 80,000 drums that were then stacked in an area to the east of the C pond. The sludge in these drums was subsequently repackaged as discussed in Section 4.1, and the unit was closed in 1992.

In conjunction with the B pond, the K-1407-C retention basin, or C pond, was built in 1973 for the storage of sludge dredged from the K-1407-B holding pond. The sludge also contained radioactive constituents and corrosive materials. The pond was approximately 300 feet long and 75 feet wide, with a holding capacity of about 2.5 million gallons. The first attempt to characterize the constituents in C pond was conducted in 1984.

The K-1007-B pond, constructed in the 1940s, covered approximately 25 acres and was located outside the security fence of the ORGDP facility. From the beginning of Plant operations until 1985, chemical byproducts from routine analytical laboratory operations were discharged to this pond at a rate of approximately 2,200 gallons per year. The pond also received storm drainage from the switchyards, process area, and storm drains that resulted in additional chemical and PCB contamination.

Beginning in the late 1950s, the K-901-A pond, located west of the K-31 and K-33 buildings, received wastewater discharged from uranium enrichment operations at K-31 and K-33. The discharge consisted largely of sludge and blowdown water from cooling operations and contained heavy metals, including chromium. Sediments in the pond contain PCBs.

When the cascades were in operation, the process cooling water systems at ORGDP employed an open recirculating water system that recirculated water through cooling towers to dissipate the heat from the cascade. The water in the cooling tower had to be treated to protect the system piping and heat exchangers from corrosion, from excessive scale formation on the heat transfer surfaces, and from growth of algae. The use of hexavalent chromium in the water treatment program for the ORGDP cooling towers can be traced back to 1956. The cooling water that was blown down to prevent the buildup of dissolved solids was discharged to a nearby stream. Associated with K-25 operations, about 1 mgd of blowdown was discharged through a holding pond, a limestone neutralizing bed, and then to Poplar Creek. Blowdown from cooling towers supporting other cascade buildings discharged through K-901A into the Clinch River. Concentrations of hexavalent chromium in Poplar Creek reached 0.05 mg/L, and in the Clinch River downstream of Poplar Creek, 0.01 mg/L.

K-1407 Holding Pond and Retention Basin

Effluents from Decontamination and Uranium Recovery

Effluents from decontamination and uranium recovery operations at the ORGDP were significant contributors to environmental contamination. From the mid-1940s until the mid-1980s, facilities in Buildings K-1410, K-131 and 132, K-1303, and K-1420 were used to decontaminate Plant equipment and materials and to recover uranium from decontamination solutions. Effluents from these decontamination and recovery processes contained residual uranium as well as transuranics and fission products. These effluents also contained chemical contaminants associated with the recovery of uranium from mercury, oils, magnesium fluoride trap media, and organic solvents such as carbon tetrachloride. Some effluents from these processes were drained to onsite ponds that overflowed to Mitchell Branch or Poplar Creek, and some were discharged directly to Poplar Creek. Decontamination and recovery processes are discussed in detail in Section 3.1.3 of this report. Effluents from each facility are summarized below.

K-1410. Decontamination of Plant equipment in Building K-1410 began in 1946 and continued until 1962. Most of the uranium removed by decontamination was from recycled reactor tails, and thus contained transuranics and fission products, including technetium-99, which were concentrated in effluents by the recovery process. Waste generated from uranium decontamination and recovery operations also included nitric acid; organic degreasers, including carbon tetrachloride, TCE, and perchloroethene; and Miller's Fluorinated Lubricant oil. Cleaning solutions were routinely discharged into the building's process drains. Degreasers were occasionally discharged down the drains. A pit that discharged directly to Poplar Creek was used to decontaminate barrier filters from the main feed plant, which were highly contaminated with transuranics, uranium daughter products, and fission products. Decontamination and cleaning solutions from the K-1410 building were transported to K-131 for recovery if economically feasible; otherwise, solutions were discharged directly to Poplar Creek. In 1963, the K-1410 facility was modified for use as an electroplating area. A limestone-filled pit was installed on the bank of Poplar Creek and used to neutralize acid discharges from the plating operations. An underground pipeline from the K-1410 facility was installed at the side of the bank above the pit to discharge the plating effluents. Subsequently, a neutralization basin with pH control replaced the limestone pit. In 1979, these operations ceased.

K-131 and K-132. Decontamination and recovery operations were conducted in Buildings K-131 and K-132 from 1948 until 1954, when these operations were transferred to K-1420. Effluents from these processes included uranium, transuranics, and fission products as well as nitric acid. Carbon tetrachloride was likely released in 1949 when 16,000 gallons of this solvent were distilled in K-131 because building drains discharged to Poplar Creek via the site storm sewer.

K-1303. Facilities for decontaminating converters and recovering uranium from decontamination solutions were operated in Building K-1303 from 1948 until 1955. Specialized facilities for recovering uranium from calcium fluoride, magnesium fluoride, chlorine trifluoride, and oil also operated in this building. Radioactive constituents in effluents included uranium, transuranics, and fission products. Chemical constituents included nitric acid, ammonia, detergents, fluorides, and oil. Building drains were discharged to a holding pond.

K-1420. Decontamination and recovery operations were carried out in Building K-1420 from 1954 until 1985. Equipment was decontaminated with nitric acid solutions, and fluorine was used to convert uranium oxides to UF_6. Parts were degreased with TCE and Freon-113. Radioactive constituents in effluents included uranium, uranium daughter products, transuranics, and fission products. Chemical constituents included nitric acid, ammonia, organic solvents, detergents, fluorides, and oil. Liquid waste discharges from the uranium recovery operations passed through the K-1407-B settling pond, where insoluble uranium compounds settled out. Soluble compounds were discharged to Mitchell Branch, which flows to Poplar Creek. In addition to recovery, degreasing operations were conducted in the K-1420 building. During early operations, spent degreasing solutions were discharged directly to the K-1407-B holding pond through a process drain line if the solutions contained low concentrations of uranium.

Releases of liquid technetium-99 to Mitchell Branch and Poplar Creek have occurred chiefly from uranium recovery operations at ORGDP. In addition, there were three onsite areas that retained significant amounts of technetium-99: the K-1407-B holding pond, the K-1407-C retention basin, and the powerhouse area scrap metal yard. Sediment samples from the K-1407-B pond indicate the presence of about 4.5 curies of technetium-99, chiefly bound to the sediment. Technetium-99 was also released into the environment in the scrap yard due to the weathering of cascade process equipment removed from operations and placed into long-term outdoor storage. Due to the nature of the scrap, technetium-99 levels were impossible to estimate. However, samples of the rainwater runoff from the scrap yard reported technetium-99 levels in the range of 0.5 to 0.8 curies per year flowing into the Clinch River. Beginning in 1987, concentrations of technetium-99 were measured monthly in Poplar Creek around ORGDP. Concentrations from 1987 to 1995 ranged from less than the detection limit to 1,860 pCi/L. During this same period, concentrations downstream in the Clinch River ranged from less than the detection limit to 1,640 pCi/L.

4.3.3 Accidental Releases

Accidental releases of chlorine, PCBs, and acids have occurred throughout the history of the Plant, contributing to environmental contamination and resulting in a number of fish kills. Fish kills have occurred in Mitchell Branch due to toxic conditions created by elevated chlorine values. Toxic conditions in both November 1988 and 1990 resulted from low flow in the stream combined with high effluent flow from storm drains in the Mitchell Branch watershed. K-1515 sanitary water plant process water was pumped from the Clinch River for use as potable water for the ORGDP. The K-1515-F holding lagoon is a small (less than one acre), shallow pond that receives chlorinated discharges from filter backwashing and settling basin overflows. In the past, discharge from filter backwashing resulted in high concentrations of total residual chlorine in the lagoon and in the lagoon outfall to the Clinch River. As many as 100,000 gallons of chlorinated backwash could enter the lagoon over a one-hour period. This rush of chlorinated backwash was the reason for several fish kills in the Clinch River, including major ones on December 14, 1988, and November 27, 1989.

Based on Plant records, approximately 125,000 gallons of PCB oils were contained in about 200 electric transformers and 10,000 capacitors used at ORGDP. Although the volumes of PCB released are unclear, it appears that they were primarily released in small quantities associated with their widespread use in electrical equipment. In addition, PCBs likely migrated off site as a result of storm water runoff, drainage from process areas, discharges from wastewater in onsite holding ponds, and flooding at the waste storage areas.

Acid spills have occurred regularly over the history of the Plant, mainly in conjunction with the decontamination and recovery facilities. As a matter of practice, acid spills were diluted with fire hose water by the site's fire department. The runoff created by the fire hoses was allowed to drain into the storm water sewer system and to either Poplar Creek or Mitchell Branch. This practice was also used on gasoline, solvents, and most water-compatible chemicals used by the Plant. The likely pathway to the nearby creeks was the storm drain system, which is still in operation today.

In summary, liquid process effluent discharges and accidental releases of hazardous and radioactive material over the course of the ORGDP operating history have had an adverse impact on the environment and the aquatic habitat in the streams and rivers surrounding the Plant. Many process releases were held up or recovered through wastewater treatment and recovery systems; however, numerous discharges from ORGDP operations flowed directly to various Plant outfalls, ponds, and storm drains and subsequently into Mitchell Branch, Poplar Creek, and the Clinch River. There were other discharges from uranium decontamination buildings, many of which were never historically monitored. Water quality was enhanced by the promulgation of new environmental regulations and the curtailment of Plant operations in the 1970s and 1980s, but contaminated storm water runoff created discharges that continued to impact waterways through more gradual releases of radioactive materials and chemicals.

4.4 Atmospheric Releases of Radioactivity and Fluorine/Fluorides

- *Release Studies*
- *Stack Emissions*
- *Accidental Releases*
- *Diffuse and Fugitive Emissions*
- *Planned and Unauthorized Emissions*

Radioactive and fluorine/fluoride airborne emissions occurred from the beginning of production in 1944. The sources have changed over time and include emissions coming from the liquid thermal diffusion process, the gaseous diffusion processes, the feed plant, diffuse and fugitive sources, planned and unauthorized releases, and accidents. The liquid thermal diffusion process operated from September 1944 until it was shut down in September 1945. The feed plant operated from 1950 until shutdown in 1961, and the gaseous diffusion process operated from 1945 until 1985. Radionuclide emissions consisted primarily of isotopes of uranium and associated daughter products and, starting in 1953, technetium-99. There was also the potential for some limited airborne transuranic releases in some locations. The principal non-radionuclide emissions included fluorine and HF. Ambient air sampling for uranium was performed around the site starting in 1959. A network of samplers was used until 1965, when sampling was reduced to the present two locations.

4.4.1 Release Studies

Uranium releases were probably the best documented of all historical releases from ORGDP because of the importance of enriched uranium to the site mission. Three different historical uranium release studies were conducted, with the most recent and most complete being the dose reconstruction study performed by ChemRisk® in 1999. This study estimated the total uranium releases to the air for ORGDP to be approximately 16,000 kg from 1944 to 1988, consisting of approximately 11 curies of uranium-234/-235 and 5.4 curies of uranium-238. Nearly two-thirds of the releases occurred in six of the 41 years between 1944 and 1984, with a large fraction (nearly 3,000 kg) coming from operation of the thermal liquid diffusion process at S-50 from September 1944 to September 1945. Releases from this facility represent approximately 20 percent of all the historical releases.

Emissions to the atmosphere decreased after the feed plant shut down in 1961. A second decline in emissions occurred after 1977 with the installation of scrubbers on the purge cascade. The July 1999 ChemRisk® dose reconstruction study noted estimated airborne releases of technetium-99 from 1953 through November 1961 for the K-1131 feed plant and from 1953 to 1973 from the purge cascades. Estimated results are uncertain since technetium-99 was not understood to be a significant contaminant in the gaseous diffusion process until the early 1970s, and was therefore not tracked or measured by the site before then. Estimates were made of 7.3 curies per year from the K-1131 stack from 1953 to November 1961 and 2.5 curies per year from the purge cascade for 1953 to 1973. These estimates for technetium-99 were based on a 5 percent release factor for K-1131 and results of stack monitoring for a three-year period from 1974 through 1976 for the purge cascade. A 1978 study estimated that 8 kg (140 curies) of technetium-99 was released to the atmosphere over a 26-year period. From 1974 to 1984, a total of 9.9 curies of technetium-99 was released, based on stack sampling results. Combined, this represents approximately 140 curies of technetium-99 released to the atmosphere.

Plant records were examined to determine the completeness of the 1999 dose reconstruction study. While the study included most of the releases identified by the EH investigation team, a significant number were not included. For example, an examination of the material release records shows that data from 1945 to 1949 was not included in the study. Several releases during this period were described as "large," although the loss was not quantified. In addition, a material balance report for five months' operation of S-50 noted that 4,700 lb (2,132 kg) of feed material had been lost to accidents and leaks. Assuming constant releases, this suggests a monthly loss rate of approximately 939 lb (426 kg). Furthermore, if the feed material unaccounted for during this five-month period (9,525 lb or 4,320 kg) was assumed to be lost to the atmosphere, this would result in an additional average loss of 1,883 lb (854 kg) per month. As a result, the 6,613 lb (3,000 kg) total release reported in the dose reconstruction study for the 12 months of operation could be a significant underestimate. Finally, an examination of the dose reconstruction records indicates that the November 1954 monthly report, a full two years after startup, was the first mention of airborne releases from the K-1131 feed plant. Since the feed plant was a major contributor to emissions, potentially significant releases between 1950 and 1953 were not accounted for.

In 1986, Lay and Rogers performed a study of health effects from historical releases at ORGDP. The cumulative annual dose from 1946 to 1984 was calculated to be 20 person-rem for the population within 50 miles of the Plant, which by their calculations represented 0.02 percent of background radiation. However this study did not include the S-50 releases. Also, as discussed in this section, other significant unaccounted-for releases may have occurred that have not been factored into prior dose assessments.

Fluorine and HF releases at ORGDP, both routine and accidental, have not been well documented. Since HF is produced by hydrolysis of UF_6 during release to the atmosphere, some HF releases can be estimated based on historic UF_6 releases. However, at ORGDP, fluorine and HF were also vented directly to the atmosphere during cascade and feed plant operations. These emissions were reduced in the early 1960s after the feed plant shut down and in the late 1960s when scrubbers were installed to neutralize the HF. Also, during the early 1950s, leaks from fluorine production were common and the conversion process in the feed plant normally ran with 5 percent excess fluorine, which was vented to the atmosphere. The feed plant later was modified to capture the excess fluorine by passing it through the cleanup reactor. Evidence of fluorine and fluoride releases was found in a fluoride vegetation damage study performed for ORGDP in 1957. This study indicated atmospheric releases of 12,500 lb of fluorine in 1954, increasing to 22,000 lb in 1957. The study also indicated releases of 58,500 lb of HF in 1954, decreasing to 44,000 lb in 1957. The study attributed some of the damage that was found to an acute, massive release rather than chronic releases.

4.4.2 Stack Emissions

Periodic sampling was performed on ORGDP vents and stacks, including the purge cascades, the seal exhausts, the feed plant, and the K-1420 building. Records indicate that the accuracy of stack monitoring, particularly before the 1970s, was suspect. For example, before 1971 a small number of 24-hour samples were taken, some as short as 10 seconds (gas bulb), and the results were extrapolated to represent an entire month. These limited measurements were insufficient to accurately characterize releases. In addition, process upsets occurred regularly, releasing UF_6 to the atmosphere. On average, there were three or four such upsets per year in the purge cascades. Similar methods were used to estimate emissions from the seal exhausts, the feed production facility, and the K-1420 stack. In late 1971, a continuous bubbler sampler was installed on the purge cascade vent, allowing continuous stack measurements and more accurate estimation of vent releases.

Although technetium-99 was present in the early 1950s in the recycled reactor fuel, it was not noted as a problem in the purge cascade until the early 1970s. An instrument technician working on a plugged line connected to a chromatograph for the purge cascade received a skin contamination that was difficult to remove. The contamination was identified as technetium-99. After the recognition that this radionuclide was being released, a stack monitoring program was started in the purge cascade vent in 1974. In 1976, a large technetium-99 release was measured, associated with purging in preparation for CIP/CUP. Scrubbers were installed in 1977, considerably reducing technetium-99 emissions.

4.4.3 Accidental Releases

Accidental releases have involved the emission of UF_6, fluorine, and fluoride. (No data is available on accidental releases of technetium-99.) Accidental releases constitute more than half of the releases of gaseous uranium effluents from the site. Most of the uranium, totaling 10,700 kg, was released during 1945, 1952, 1953, 1958, 1960, and 1962. The 1999 dose reconstruction study found that approximately 9 percent of all releases were environmentally monitored.

The earliest accidental releases came from the S-50 plant. Interviewees noted that accidental UF_6 releases from S-50 were frequent and large. High pressures used in the process, approximately 1,500 psia, essentially guaranteed that when a release occurred it would be significant. The large amount of tubing used in this process, which contained numerous welds, increased the probability of leakage.

Site management established a system in 1945 requiring the formal reporting of releases of uranium. Nearly 1,000 material release reports were developed that document both accidental and process releases at ORGDP. A January 8, 1952, memorandum relating to improvements in material release reporting questions the effectiveness of the reporting system, stating that "However, in K-1131, K-1405, etc, when the release of material is more or less expected as one of the evils of operation and is a daily occurrence, we still won't get reports."

The largest release after the shutdown of S-50 was on December 30, 1952. A valve failed on a feed cylinder, releasing approximately 770 kg of UF_6 to the atmosphere at K-402-1. Another large release occurred on September 19, 1952, when a cold trap rupture disk failed at K-1131, venting approximately 300 kg of UF_6 to the atmosphere. On June 1, 1953, the upper part of a valve was blown from a one-ton UF_6 cylinder that was being heated at the K-1131 building. Approximately 270 kg of uranium was rapidly released to the atmosphere. The drifting cloud required evacuation of personnel in a number of buildings.

Accidental releases also involved fluorine and/or fluorides. A fluorine production plant was built in K-1301 in the 1940s, and the fluorine was piped to K-1302 for storage. The three fluorine storage tanks were equipped with rupture disks that failed numerous times, releasing the entire fluorine content of the tank. These early failures were reduced considerably when the rupture disks were modified. Also, during fluorine production, some material not properly meeting quality control requirements was vented directly to the atmosphere in the 1960s after the feed plant shut down.

During repair of a transport line in the 1974-76 time frame, a 5,000-lb HF release occurred when the repairman sawed into the transfer line on the wrong side of a valve. Some accidental releases were documented in event reports and material release reports. As noted above, the smell of fluorine and HF was frequently present when UF_6 was being produced. Damage from the releases included etching of glass window panes.

4.4.4 Diffuse and Fugitive Emissions

Several mechanisms could have allowed the release of uranium containing small quantities of transuranic materials during handling of ash receivers, maintenance activities, and various processing activities.

The ash from the K-1131 feed plant was collected in ash receivers during production of UF_6. After collection, these were capped and were placed to the west of the K-25 building to allow the uranium daughter products to decay. These ash receivers contained unreacted UF_6 as well as transuranics from the processing of reactor returns. They were stirred several times a day to release entrained gases. In 1960, while ash receivers containing significant amounts of UF_6 were being emptied into drums at K-1410, UF_6 was vented into a hood and exhausted out of the unmonitored building stack. During heavy releases, plumes of hydrolyzed UF_6 were observed blowing back into the building.

UF_6 was frequently released during CIP/CUP changeout of the major equipment for the cascades. These releases occurred generally within the buildings, but would also be partially released to the environment through ventilation. In the K-1420 building, during processing of special nuclear materials from the Savannah River Site in November 1960, an estimated airborne release of approximately 1 kg of uranium occurred over a six-day period due to releases from the pulverizer, hopper, and feed screw units.

Not all fugitive releases were appropriately reported. For example, a former cascade manager described a significant release from a building that was not formally reported. This manager also indicated that other UF_6 releases were not reported. The absence of accurate release reporting affects the accuracy of uranium release estimates.

4.4.5 Planned and Unauthorized Emissions

A number of planned releases were carried out at ORGDP. At S-50, approximately eight pounds of UF_6

Hydrogen Fluoride Being Released; Note Cylinder and Operator Bottom Left Corner

was allowed to interact with the surface of the tubes and was later vented to the atmosphere. In 1965, five outdoor fire tests of UF_6 cylinders were run, with a total release of 188 kg of uranium. Also in the early 1970s, two sets of controlled releases of UF_6 were performed because of the difficulties in estimating the size of UF_6 releases. The first set was conducted in a laboratory and photographed, and the second set was made in process buildings to determine whether detectors could alert operators of a release from cells in the cascades. In both tests, releases ranged from 1g/minute to 100 g/minute for a period of 10 to 20 minutes.

There is evidence that unauthorized releases may have occurred during preparation of the cascade cells for maintenance. Because of the flexibility built into the design of the ORGDP systems, alternative flow paths and practices that could release process gases to the environment were possible; some of these were not authorized in procedures. Reportedly, improper emissions increased during CIP/CUP due to management pressure to stay on schedule. Significant quantities of UF_6 could have been available for release to the environment. The number and frequency of unauthorized releases were not determined and were not included in published release estimates. Other authorized releases of process gas occurred when problems were encountered with the operation of the K-25 building cascade prior to 1956 (see Section 3.1 for a more detailed discussion of cascade operations).

In summary, radioactive and fluorine/fluoride air emissions to the atmosphere began with Plant startup. Several studies of historical airborne radionuclide releases from K-25 have been performed, the most complete being a 1999 dose reconstruction study performed by ChemRisk®. This study indicated that nearly 16,000 kg of uranium, approximately 11 curies, were released from 1953 to 1988, and that approximately 2.5 curies per year of technetium-99 may have been released. A 1978 study, which measured stack emissions, indicated that approximately 140 curies of techetium-99 were released to the atmosphere over a 26-year period (1953-1978). Technetium-99 estimates have a significant amount of uncertainty, because there was no actual sampling of this material before 1974. A review of the dose reconstruction study and available ORGDP radionuclide release records revealed that while most releases were included in the study, a significant number of releases during the 1945 to 1949 time frame were not; therefore, the published estimates are likely too low.

4.5 Sanitary Water System

Radionuclides from upstream sources have infiltrated the ORGDP sanitary water distribution system for decades. For example, ORNL has impacted the White Oak Creek watershed with radionuclides. These contaminants worked their way downgradient and downstream to the Clinch River and have impacted the location where White Oak Creek discharges into the river on north side. The intake for the ORGDP water supply is also located nearby downstream of ORNL on the north side of the Clinch River. After being diluted in the river, the contaminated water was pumped into the K-1515 water treatment facility in low concentrations. These concentrations have been monitored and reported for years. As an example, on December 2, 1985, a discharge of strontium-90 was detected in White Oak Creek near ORNL. Water samples collected at the intake to the water plant indicated the presence of strontium-90 in concentrations above drinking water standards. It was determined that short-term usage of this water would not be a health concern because the drinking water standards are based on long-term, chronic consumption. However, as a precautionary measure, the ORGDP water plant was shut down the same day.

Data from 1960 yielded examples of documented radionuclide analyses of both the river water and the finished water from the K-1515 water treatment facility. Gross beta activities were reported during this time on a daily basis. A review of limited data available during the timeframe of this review indicated that radioactivity flowed down the river and entered the K-1515 facility in spikes. For example, the gross beta activity in the river spiked to 19,238 pCi/L on February 19, 1960, with a 13-week average during that period of 2,657 pCi/L. On February 11, 1960, a gross beta activity of 30,099 pCi/L was measured in the river water. A spike of beta activity of 9,306 pCi/L was reported in finished water from the K-1515 facility on November 15, 1960. The beta activity in these reports was likely from strontium-90 and cesium-137 from ORNL; however, isotopic data were not reported to confirm this. Although specific drinking water standards for radionuclides did not formally exist at the time, comparison with today's standards illustrates the relative extent of the contamination. For example, the current Derived Concentration Guides (DCGs) for strontium-90 and cesium-137 are 1,000 pCi/L and 3,000 pCi/L, respectively. Drinking water standards are approximately 4 percent of the DCG, or 40 pCi/L and 120 pCi/L for strontium-90 and cesium-137, respectively. These values would result in an effective dose of approximately 4 mrem per year using the conservative consumption rates. While these concentrations from 1960 exceed today's standards, acute health effects would not be expected from them. This review of data has not been exhaustive. However, as with all chronic radiological exposures, risks increase with increasing dose, and the regulatory concept to maintain exposures ALARA, which was in place at the time, does not appear to have been fully evaluated against these data. Beta activity is currently monitored and compared to the standards on a regular basis at the K-1515 water supply facility.

In addition to contamination from upstream sources, the sanitary water system was also subject to potential contamination from cross-connections with other water systems in the Plant. The original design of the sanitary water system maintained physical separation from other systems, so the sanitary water system did not utilize backflow preventers. However, interviews and Plant records indicate that some unprotected cross-connections and tap-ins between sanitary water and other water systems, such as the fire water system or other non-potable systems, were installed over the years. For example, a 1984 drawing provided evidence that a sanitary water supply line had previously been tied directly to the UF_6 feed autoclaves in Building K-1131. A safety assessment performed in May 1983 stated that "the many modifications and additions occurring over the years to the potable sanitary water system have significantly added to the potential risk of cross-connection between the potable and non-potable systems." During interviews, current and former site workers alleged cross-connections of fire water and/or cooling water systems to the sanitary water system due to unauthorized or erroneous system modifications and practices. In some cases, the connected system was at a higher pressure than the sanitary water, particularly during periods of maintenance on the sanitary water system. In most cases, double valve isolations were utilized in the installation, although backflow prevention devices were not always used. Consequently, some contamination of the sanitary water system by other water systems may have occurred. Because of the practice of flushing lines following maintenance, it is unlikely that drinking water was contaminated at significant levels for long periods of time. Contaminants of primary concern are chromates or other corrosion inhibitors, as well as a variety of biocides and fungicides from the recirculation cooling water system. Regulations required contamination-monitoring only of water leaving the treatment plant. Consequently, the Plant performed minimal measurements of concentrations of potential contaminants resulting from cross-connections. Of the limited monitoring data discovered, the EH team found no indications of chemical contamination within the sanitary water system resulting from cross-connections.

In 1983 and 1984, the site performed an extensive project to identify the cross-connections and install appropriate protection, such as backflow preventers and anti-siphon devices. Numerous devices were installed, primarily in applications such as janitor closets and air conditioning cooling coils. In 1991, the Tiger Team assessment found that the backflow prevention program had deficiencies, but identified no unauthorized or unprotected cross-connections. The site developed and implemented corrective actions to address the Tiger Team findings. On February 1, 1994, TDEC performed a sanitary survey, accompanied by DOE personnel performing a concurrent ES&H appraisal at the ORGDP. The DOE appraisal commended the facility management, operators, and staff for the “well deserved (high) score” given by the TDEC survey. Periodic monitoring of the sanitary system by the contractor and the State of Tennessee continues today.

4.6 Environmental Management Summary

Activities to manage the large volumes of wastes and effluents from operations at ORGDP evolved in response to internal and external requirements over the Plant’s operating lifetime. The generation of waste and scrap materials began with Plant construction in the 1940s and continued into the 1980s. Guidelines for handling, storing, and disposing of waste in the early days of Plant operations were very general, and onsite sanitary landfills and sewage systems likely received some contaminated material since waste segregation practices were not fully understood or effective. As new requirements were enacted, additional waste streams, such as hazardous wastes and PCBs, were restricted from disposal in onsite landfills.

Early waste management practices focused on burial and incineration. The more stringent environmental regulations in later years resulted in diminished or non-existent disposal capacity for some wastes, increasing the site’s reliance on finding and managing waste storage locations and developing treatment technologies. During the Plant’s history, various disposal sites and methods were used, including a variety of sanitary, radioactive, and classified landfills; burn pads and incinerators; waste treatment pits and ponds; oil biodegradation plots; and some unauthorized disposals. Most of the formerly used sites are now closed and/or awaiting remediation under CERCLA. Additional sites that may have been used for waste treatment and disposal activities that were discovered in the investigation will require additional screening and investigation. Disposal restrictions instituted in the 1970s on PCB-contaminated waste materials and oils resulted in rapid accumulation of large quantities of these wastes and a decision to construct a TSCA incinerator in the 1980s. The construction, permitting, and eventual operation in 1991 of the K-1435 TSCA incinerator filled a critical need in managing the inventory of stored PCB wastes.

Large volumes of contaminated metal and surplus material not considered wastes were also generated during construction, maintenance, repair, and facility upgrade activities at ORGDP. In many cases, these materials represented valuable commodities that could be recycled for continued Plant use or reintroduced into commerce by public or commercial sale. Large volumes of scrap metal were smelted by various organizations and cast into metal ingots for resale and reuse in the public domain. It is clear that efforts were taken to properly segregate contaminated materials from clean materials intended for sale to the public. However, given the lack of effective scrap segregation controls and the limited number of qualified health physics personnel available to perform radiological surveys, it is evident that material exceeding appropriate radiological release guidelines was periodically released from the Plant’s control from the 1940s through the 1980s.

Liquid effluents have been routinely discharged from the Plant during normal operation and from accidental spills and releases. Effluents were historically released in a number of ways, including via the sanitary sewage and storm water drainage systems. Effluent material that was not otherwise held up or recovered through wastewater treatment facilities and recovery systems flowed to the various regulated Plant outfalls and storm drains, and into Mitchell Branch, Poplar Creek, and the Clinch River. Since 1959, environmental data for ORGDP have been collected and analyzed to determine the impact of discharges on environmental media. Liquid effluents were not analyzed for transuranics and fission products in the 1950s, when use of reactor tails to manufacture feed materials began. Appropriate monitoring for these radionuclides began in the mid-1970s.

In the early 1970s, the CWA established the NPDES, which administered effluent limitations and water quality restrictions for chemical releases. Liquid effluent discharge limits for radionuclides were not promulgated by EPA at that time, but were always required and published under AEC and ERDA regulations and later documented in DOE orders. Despite discharge restrictions, it is clear that enough radionuclides and chemicals have been released to create legacy contamination; this has been confirmed through environmental sampling. The lack of comprehensive monitoring in all affected locations, the presence of surface runoff from contaminated areas, and the occurrence of accidental releases have all contributed to the buildup of environmental contamination in and around ORGDP.

Radioactive and fluorine/fluoride air emissions to the atmosphere began with Plant startup. The sources have changed over time but have included emissions from the liquid thermal diffusion process, the gaseous diffusion processes, the feed production plant, diffuse and fugitive emissions, some likely planned and unauthorized releases, and accidental releases. Ambient air sampling for radiological contaminants was initiated in the 1960s; however, the monitoring network was limited and was reduced to only two locations in 1965. The principal radionuclides released to the air from ORGDP operations were isotopes of uranium and technetium-99. Other radionuclides, including transuranics and iodine, were also released at various times.

ORGDP records indicate that nearly 16,000 kg of uranium, approximately 11 curies, were released to the atmosphere between 1944 and 1988. Nearly two-thirds of this total was estimated to have been released in the first six years of Plant operation, with 3,000 kg released from the S-50 thermal diffusion facility in 1944 to 1945. The feed production facility, which operated from 1950 to 1961, and the cascade buildings were also major sources of uranium emissions. There are concerns that uranium emissions may be underestimated because of inadequate accounting for releases from operations that may have contributed uranium, such as ash handling and work for others, and because of improper release documentation by cascade operations personnel.

Holding Pond Annually Received 2,200 Gallons of Laboratory Waste Until 1985

A 1978 study and stack sampling indicate that approximately 140 curies of techetium-99 were released to the atmosphere from 1953 through 1978. Although technetium-99 was present from the early 1950s in recycled reactor fuel, this isotope was not known to be a significant concern until the early 1970s, when it was discovered as contamination on an instrument technician's skin. Therefore, technetium-99 release estimates, particularly in the early years, are likely underestimated.

Workplace air samplers, as well as evidence of contamination on roofs and grounds, point to the presence of other unmonitored releases. There is also evidence that planned releases may have occurred through jetting of process gases from unmonitored vents in preparation for cascade cell maintenance. These releases are factored into current historical release estimates. Fluorine and fluoride compounds were used at ORGDP and were vented periodically to the atmosphere as waste gases. Although these releases have not been well documented, there was a 1957 study of vegetation damage, as well as reports by Plant personnel of offensive fluorine and HF fumes, which at times were described as overpowering.

Radionuclides from upstream sources have infiltrated the ORGDP sanitary water distribution system for decades. A review of available data indicated that radioactivity flowed down the river and entered the K-1515 facility in spikes. While the concentrations exceed today's standards, acute health effects would not be expected from them. However, as with all chronic radiological exposures, risks increase with increasing dose, and the regulatory concept to maintain exposures ALARA, which was in place at the time, does not appear to have been fully evaluated against these data. In addition to contamination from upstream sources, the sanitary water system was also subject to contamination from cross-connections with other water systems in the Plant, and some contamination of the sanitary water system by other water systems was possible. Of primary concern is potential contamination from the recirculation cooling water system that contained chromates or other corrosion inhibitors, as well as a variety of biocides and fungicides. In 1991, the Tiger Team assessment found that the backflow prevention program had deficiencies, but found no unauthorized cross-connections. Periodic monitoring of the sanitary system by the contractor and the State of Tennessee continues today.

5.0 Past Management and Oversight Practices and Employee Relations

5.1 Oversight

The U.S. Army (1943-1946), AEC (1946-1975), ERDA (1975-1977), and DOE (1977-1997) had a nearly continuous presence at the ORGDP, with an operations office located nearby in Oak Ridge. Federal officials were located on site, performing a variety of functions at various times, with a separate K-25 Site Office established in the late 1980s. However, much of the early oversight effort was directed at ensuring effective development of diffusion-related technology and timely production of enriched uranium, with health and safety reviews performed as an adjunct function or in reaction to the most serious events or accidents. In July 1957, the manager of the AEC Oak Ridge Operations Office formed a Health Protection Study Committee that conducted an onsite review of ORGDP health policies and practices. The committee concluded that worker health was being well protected but that more engineering controls should be used for routine operations. Accordingly, the committee strongly recommended that "the use of respirators be limited to short-term or emergency operations," stating that the use of respirators as a protective measure was overemphasized at ORGDP. The committee also concluded that the Plant's acceptance criterion for uranium in urine, "no significant internal deposition," was "unnecessarily costly," as was the collection of urine samples more often than quarterly. The report stated that the Union Carbide radiological work restriction limits of about two times background "were several orders of magnitude below damage levels" and should be "seriously reviewed."

The AEC/ERDA/DOE field offices conducted annual health protection appraisals and safety surveys and semi-annual fire protection surveys from 1961 through at least 1984. In 1965, OR policy shifted the nature of health protection reviews from onsite inspections to program assessments, although assessments in the 1970s indicate that some field evaluations were being performed. In the late 1960s, these reviews also included environmental protection and criticality safety programs. These appraisals were quite limited in scope, and findings were typically few and minor. Some exceptions included several OR safety surveys in the mid-1960s that took an aggressive position, calling the ORGDP safety program "barely satisfactory," with numerous findings and recommendations. However, in general, the annual health protection reviews documented few findings and praised the ORGDP, characterizing the industrial hygiene and health physics programs as excellent or superior, with strong management support. In the late 1980s and 1990s, OR performed periodic management and functional team assessments, along with environmental surveys and audits consistent with DOE Order 5482.1A, *Environment, Safety, and Health Appraisal Program*, issued in 1981. These assessments evolved into more comprehensive and aggressive reviews, especially after the DOE Headquarters Tiger Team assessment in 1991. For example, the 1992 ES&H and Quality Assurance appraisal of the ORGDP involved 39 team members and evaluated 23 functional areas; it identified 73 environmental deficiencies, 53 safety and health program deficiencies, and ten quality assurance deficiencies.

In the 1940s, safety and health issues were of great interest and concern to the Army Corps of Engineers Manhattan Engineer District command staff, the AEC, and their academic consultants. Extensive research at offsite locations, a considerable number of trips to ORGDP by leading government and university scientists and engineers, and extensive correspondence reflect the interest in understanding the health effects and establishing the necessary controls for safe operation of the ORGDP. However, in the late 1940s, the level of offsite research and oversight activity related to safety and health appeared to significantly diminish once the controls and standards were established, the basic technology and processes were proven, and the ORGDP began full operation. AEC/ERDA

K-25 Spectrometer Master Control — May 1945

the coverage required by the program" and cited a shortage of safety and health staff at OR. Also identified as weaknesses were delayed and inadequate corrective actions for known contamination control problems that were not addressed until the union issued formal complaints. The DOE disputed the significance of GAO's concerns.

During the late 1940s, the contractor's ES&H staff provided effective oversight of ES&H, supporting the development of safety standards, successfully introducing enhanced protective measures and equipment, monitoring and reporting on ES&H performance, and recommending improvements in worker, public, and environment protection programs. However, in the early 1950s, the contractor formally shifted responsibility for the conduct and supervision of the ORGDP safety programs to the line organizations, relegating the ES&H organization to an advisory and support role, with reduced staffing and authority. Interviews suggest that line supervisors were not adequately trained to assume these additional responsibilities, were not as conservative in establishing protective measures or assuring that safety program requirements were met, and removed or failed to utilize some of the earlier established enhancements to ES&H programs. During the 1950s and 1960s, the contractor's ES&H organizations functioned primarily as advisors, performing some contamination/radiation monitoring, setting standards, and maintaining exposure records. Many of the few ES&H staff were matrixed to production groups. In 1966, site policy changed to further limit the oversight activities of the health and safety division, with operations and maintenance divisions responsible for conducting industrial hygiene and health physics surveys and safety inspections, and maintaining associated records. The safety staff conducted annual safety audits, and the health physics staff conducted "spot audits" and evaluations of line surveillance activities. In the 1970s, the safety staff initiated extensive surveys of hoisting and rigging gear and performed pressure vessel, furnace, and autoclave inspections. The contractor also formed industrial hygiene and safety/OSHA committees in 1972, with participating members from the three OR sites and Paducah. These committees conducted periodic audits into the 1980s in accordance with new company policy and DOE Order 5482.1A.

In summary, ES&H oversight activities by all parties, in the form of performance assessments, were limited. Formal functional assessments were typically

headquarters ES&H oversight activities appeared to be very limited, primarily focusing on standards development and technical support, until the late 1970s. Headquarters was involved in liaison activities and establishment of agency requirements for the growing number of OSHA and environmental regulations in the 1970s and 1980s. However, in 1972, a doctor from the AEC Headquarters Division of Operational Safety conducted an occupational medicine appraisal at ORGDP. This appraisal concluded that the ORGDP medical program was below average, citing lack of aggressiveness in physician recruitment, "totally inadequate" decontamination and surgical facilities, dirty facilities, and inadequate radiation training for new physicians, and recommending numerous changes in testing. In the 1980s, teams from DOE EH conducted periodic functional area technical safety appraisals, and in 1991 the Tiger Team assessment of ES&H programs and performance was conducted at the Oak Ridge Reservation. This latter assessment identified numerous physical, program, and performance deficiencies. One of the key management findings was that DOE's and the Oak Ridge contractors' oversight did not provide "assurance that an effective and sustainable ES&H program exists."

In 1980, the General Accounting Office (GAO) performed a review of the DOE program for ensuring the safety and health of workers at the three uranium enrichment plants. The GAO determined that program implementation was inadequate. Their report acknowledged that safety statistics and radiation exposures were low compared to similar industries, but stated that ES&H oversight "is not approaching performed only once each year by OR and contractor ES&H personnel. In many cases, it appears that the scope of assessments was minimal, they were less than aggressive, and the threshold for performance was not sufficiently high. Commonly cited deficiencies included lack of staffing, poor use of PPE, and weaknesses in industrial safety programs. However, there was evidence of proactive, coordinated preparation by AEC/ERDA/DOE and the contractors on methods for complying with emerging occupational safety and environmental regulations in the 1970s and 1980s.

5.2 Labor Relations

During World War II, union activity was considered inconsistent with the national security interests and secrecy requirements of the Manhattan Project activities at ORGDP. Hence, at the request of the Secretary of War, labor leaders agreed to relinquish their rights to organize for the duration of World War II. The Secretary of War withdrew this request in March 1946, and subsequently the ORGDP local of the Oil, Chemical, and Atomic Workers Union (OCAW) was certified on September 27, 1946. The other major union at the Plant, the United Plant Guard Workers of America (UPGWA), was certified on January 17, 1949, and included the Plant protective force and members of the fire department, commonly called “fire drivers.”

Records indicate that from 1946 through 1997 an estimated 10,000 grievances were filed, addressing a variety of issues. Most grievances focused on work jurisdiction, discipline, overtime, seniority, and other issues not related to worker safety and health. Plant operations personnel filed approximately 95 percent of these grievances, while guard workers submitted the balance. A review of selected ES&H-related grievances filed during this period indicates that labor sometimes took issue with management actions that were intended to ensure workers’ safety. For example, on May 23, 1958, and July 15, 1958, two operators protested being assigned to an 11-week operator refresher training session. One individual maintained that it was an “insult” to “repeat” the training taken three years earlier, while the other worker stated that attendance in the course would cause him to lose premium pay for the duration of the training period. In both cases, management maintained that the refresher training, which included instruction in safe operating procedures and first aid, was necessary because there had been “changes and improvements in process equipment and operating methods.” On July 29, 1958, a maintenance mechanic protested the “picayunish application of the so-called safety rule” by management after he was denied use of a forklift to raise him to work at a high elevation, despite a recent accident associated with this unsafe practice. Grievances of this nature provide evidence that some workers did not understand the risks involved with work at ORGDP and may explain the frequency of the observation of inconsistent use of PPE.

In contrast to the previous examples, there are also instances where management actions exercised in accordance with company safety policy were not always consistent with worker welfare. For example, on October 7, 1957, an operator protested management’s discontinuance of providing gloves to workers in the barrier plant, as there had been “tremendous increases” in the number of hand injuries since this action, which was substantiated by dispensary medical records. Management’s response was that gloves had been issued to protect the barrier material from being handled with bare hands, and that recent studies indicated that this practice was no longer needed. On March 23, 1961, several maintenance mechanics protested having to perform a crane changeout in K-1131, which involved removal of steel contaminated with uranium. Their request to have the steel decontaminated before removal was consistent with similar work performed by an “outside contractor.” However, the supervisor denied their request, and management maintained that the proper safety equipment and job instructions for performing the work safely had been provided.

Approximately 35 percent of all grievances filed were submitted during the first 30 years of organized labor (that is, from 1946 through 1975) and were accompanied by three authorized strikes by OCAW protesting wages, as summarized in Table 3. Approximately 65 percent of all

Table 3. ORGDP Oil, Chemical, and Atomic Workers Strike History: 1946-1997

Strike Period	Duration	Type	Principal Reason
July 7 – 10, 1954	3 days	Authorized	Wages
October 15 – 31, 1961	16 days	Authorized	Wages
October 16 – November 12, 1975	28 days	Authorized	Wages

grievances filed were submitted in the 22 years following the 1975 strike (that is, 1976 through 1997). Despite the relatively greater number of grievances filed, the union did not strike. This reluctance to strike may be partly attributable to past experience, wherein the three authorized efforts were unsuccessful in securing the initial wage demands by the union, and negotiations resulted in their accepting a significantly smaller amount. For example, in the 1975 strike, labor demanded a $0.28 hourly wage increase, and after 28 days settled for the $0.09 increase offered by management. This reluctance to strike may also reflect the union's belief that the grievance process provided an effective mechanism for resolving issues. Since its formation, the UPGWA has had no strikes.

Programs to compensate workers for injuries and illnesses were stipulated by the AEC and its successor organizations and were administered by ORGDP contractors throughout Plant history. Available records indicate that injury-reporting mechanisms were in place and claims were processed with input from Plant physicians, supervisors, insurance personnel, and employees. Most compensation claims consisted of typical construction and industrial injuries, including back strains, pulled muscles, slips, trips, falls, and lacerations. Exposure to chemicals resulting in skin rashes, and burns from welding tasks, provided cause for many ORGDP compensation claims. Inter-company correspondence from 1945 to 1965 indicated concerns about rising workers compensation costs and suggested actions to reduce claims through a variety of methods, including enforcement of safety rules and use of protective equipment through improved worker monitoring programs. However, despite the statements of several interviewees indicating that workers compensation claims were routinely unfairly rejected or disputed by contractor officials, no records that would clearly support this contention were uncovered during this investigation. The strike history and the number and type of grievances filed at ORGDP suggest that there probably was some contention between labor and management concerning the causes of worker injuries and illnesses, and the associated claims. Furthermore, the results of authorized OCAW strikes indicate that labor was not necessarily very forceful, suggesting that disputes concerning compensation claims were few in number, not lengthy, and likely settled to the advantage of management.

Interviews with some past and present employees indicate their belief that raising safety and health issues, whether by simple verbal complaints or questions, filing formal grievances, or submitting worker compensation claims, was sometimes accompanied by management retaliation. According to these interviewees, some supervisors commonly assigned individuals to undesirable tasks or Plant locations to quiet their questions or complaints about the impact of job-related activities on their safety and health. For example, workers reportedly were sent to perform decontamination tasks in K-1420 as "punishment," because working conditions in this facility were excessively dirty and noisy. Other "whipping post" assignments included Buildings K-29, K-31, and K-33, all of which were very hot and noisy, and the cooling towers, which were especially cold during winter months. In contrast, it was a common management practice to rotate workers among assignments. Sometimes individuals who were assigned tasks that involved significantly harsher working conditions may have incorrectly viewed this as punishment.

Collectively, strikes and grievances indicate a sometimes contentious relationship between management and labor. It appears that most of the disagreements were based on economics, and worker safety and health issues were either at the periphery of the argument or relatively infrequent. From 1984 to 1997, there was a dramatic decrease in the number of ES&H-related grievances filed annually. Although this correlates to a reduction in the workforce consistent with the cessation of uranium enrichment at ORGDP, it also suggests that workers were aware of their hazardous working conditions during enrichment operations and wanted to make changes. However, in most disputes, management prevailed.